Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band	)	WT Docket No. 07-293
	)	
Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band	)	IB Docket No. 95-91 GEN Docket No. 90-357 RM No. 8610

To: The Commission

COMMENTS ON PUBLIC NOTICE

Aerospace and Flight Test Radio Coordinating Council ("AFTRCC"), by its counsel, hereby submits its Comments on the Public Notice, DA 10-592, released April 2, 2010 in the above-referenced proceeding.

Introduction

AFTRCC appreciates the effort the Commission's staff has invested in this difficult and contentious proceeding. However, AFTRCC continues to be concerned over the lack of more meaningful technical solutions that could be applied to Wireless Communications Service ("WCS") operations adjacent to flight testing.

The Public Notice proposes to adopt out-of-band emission ("OOBE") limits marginally tighter than the existing Rule. Instead of 43 + 10 log(P) at 2360 MHz and 70 + 10 log(P) at 2370 MHz, the Notice proposes the same 43 + 10 log(P) at the band edge, 70 + 10 log(P) at 2365 MHz, and 75 + 10 log(P) at 2370 MHz. *Id.* at 10. Furthermore, these values would be measured using average power with peak power excursions as much as 13 dB above transmit output power.

Id. at 9. Finally, WCS would be allowed to transmit in the time division duplex (or "TDD") mode in the bands closest to AMT, namely 2345-2360 MHz.

By contrast, AFTRCC has proposed 70 + 10 log(P) at 2360 MHz after the transmit antenna at the band edge, 2360 MHz; proposed to continue the existing Rule which requires measurement of WCS out-of-band power on a peak basis; and proposed to require frequency division duplex (or "FDD"), that is, base stations only in the upper WCS bands.[1]

In other words, for base stations, the Public Notice is fully 32 dB less restrictive than AFTRCC's proposal; there is no limitation of mobiles and portables to the lower WCS bands, 2305-2320 MHz; and OOBE would be measured on a basis which permits very significant peak power excursions.

Given the inadequacy of the technical solutions, a coordination requirement for WCS is essential. Further, as discussed later in these Comments, that requirement should be strengthened.

Discussion

A. The Likelihood of WCS Interference Is Clear.

That WCS out-of-band emissions can cause harmful interference to aeronautical mobile telemetry ("AMT") is an empirical fact. Johns Hopkins documented the results of measurements taken of signals from an actual WCS transmitter on an actual AMT receiver during the Ashburn, VA tests supervised by Commission staff last Summer. These tests showed "severe" interference into the AMT receiver, even with a 4 MHz guard band between the upper band edge of the WCS signal, 2352.5 MHz, and the lower band edge of a 12 MHz AMT channel tuned to a center frequency of 2362.5 MHz, namely 2356.5.[2]

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[1] See AFTRCC ex parte filed March 31, 2010 at 15.
[2] See Engineering Statement attached to AFTRCC ex parte filed August 14, 2009 at 3.

In light of these results, the Public Notice's proposal to allow WCS to now measure its power in a manner which will yield significant peak excursions, is particularly problematic. The 13 dB peak to average ratio accompanying the change to average power measurement will exacerbate WCS interference to AMT. In fact, as the attached Engineering Statement notes, the practical effect of this change is to allow, for over 99% of the time, WCS interference in the AMT band at a level which corresponds to only $\underline{32 + 10 \log (P_{avg})}$ -- not even the inadequate 43 + 10 log (P) of the existing Rule.

B. The Operational Effects of the Interference.

Telemetry data are transmitted from distant aircraft to extremely sensitive, 8-foot or larger, high-gain, parabolic antennas. These antennas are designed to detect weak and fluctuating signals from distances of 200 miles as the aircraft undergoes flight test maneuvers. These data measure critical parameters such as stress on control surfaces, engine temperatures, fluid pressures, and many other variables. Besides greatly enhancing the efficiency of flight test programs, real-time telemetry via 2360-2390 MHz enables ground engineers to detect dangerous conditions aboard the aircraft, and warn the pilot.

AFTRCC has documented the effects of WCS interference on flight operations. Among other things, the presence of interference will directly impact the airspace available for flight testing. Instead of being able to fly out to distances of 150, 175, 200 miles and more in order to comply with air traffic control requirements, or to fly to clear sky or calm air, the reduction in reliable signal range is calculated to reduce useable airspace in half. This will leave commercial and military aircraft development programs increasingly vulnerable to delays and disruptions given the greater likelihood of encountering bad weather and air traffic restrictions in the airspace that remains.[3]

[3] See AFTRCC ex parte of October 15, 2009.

These factors directly impact flight test safety on missions and maneuvers that must be flown, and re-flown, in order to capture data lost to interference-induced telemetry drop-outs as discussed in the Engineering Statement. Many of these maneuvers, such as stall, spin, and flutter tests, are very hazardous. Requiring pilots to re-fly those maneuvers in order to secure the requisite test data is unacceptable. Interference from WCS emissions speaks to the fundamental precepts of why safety-of-life applications should be protected from harmful interference. In addition to the safety concerns, repetitious flight testing adds exorbitant costs to test programs, impacting the global competitiveness of aerospace manufacturers, and causing program delays and costs overruns for civil and military test programs.[4]

C. The Commission Has Protected AMT Against Interference.

The Commission has long recognized that flight testing is a safety service which must be protected "from harmful interference that could result in loss of life."[5] It has likewise determined that the telemetry bands should be classified as Restricted and protected from fundamental emissions of unlicensed devices. In so doing, the agency stressed that the telemetry band "involve[s] safety of life."[6]

In the same vein, the Commission has recognized that the potential cost to manufacturers and the taxpayer from interference to telemetry is significant, e.g. "[F]light test, telemetry, and telecommand operations are vital to the U.S. aerospace industry to produce, deliver, and operate safe and efficient aircraft and space vehicles."[7]

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[4] See AFTRCC ex parte filed November 24, 2008 at 13-16.

[5] *In the Matter of Amendment of Part 2 of the Commission's Rules Regarding Implementation of the Final Acts of the World Administrative Radio Conference, Geneva, 1979,* FCC 84-306, released July 2, 1984, at 2.

[6] *In the Matter of Revision of Part 15 of the Rules Regarding the Operation of Radio Frequency Devices Without an Individual License,* 4 FCC Rcd 3493, 3502 (1989).

[7] *Second Notice of Inquiry in GEN. Docket No. 89-554, In the Matter Of An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum,* FCC 90-316, 5 FCC Rcd 6046, 6060, para. 101 (1990).

Consistent with this, the United States took extraordinary measures at the 2007 World Radiocommunication Conference to protect the S-band for flight testing, obtaining the following reservation:

> "The United States of America and Canada refer to footnote number 5.394 of Article 5 of the Radio Regulations concerning the use of the 2 300-2 390 MHz band in the United States and the 2 300-2 400 MHz band in Canada and state that, in application of the Final Acts of the World Radiocommunication Conference (Geneva, 2007) in those bands, the aeronautical mobile service for telemetry has priority over other uses by the mobile services."[8]

Against this background, the WCS resistance to reasonable protections for flight test telemetry has been particularly troubling.

D. WCS Arguments Are Groundless.

Johns Hopkins University has submitted numerous engineering statements in this proceeding. These statements have particularized the WCS interference mechanism that will affect reception of flight test telemetry; have reported the results of field tests conducted using an actual WCS device and an actual AMT receiver -- tests which verified in clear terms the risk of interference; and have set forth the consequences of WCS interference to flight test operations and pilot safety.

WCS interests have not responded to these points. On the contrary, WCS parties have in effect conceded that their operations will cause interference to flight testing. See WCS Reply Comments filed March 17, 2008 at 52-53 (responding to AFTRCC's interference concerns with the statement that "AFTRCC is absolutely right" that subscriber stations could be deployed "in

[8] Declaration No. 78, Document 427-E (WRC-07) (emphasis added).

very close proximity to a telemetry receiver" and with a "clear view of telemetry ground stations").

What little WCS has said regarding AMT has referenced the handful of fixed WCS base stations installed (with prior AFTRCC coordination) over the twelve years since WCS was first licensed, with a suggestion that these have not been reported to cause interference to AMT.[9] But of course, the scale of deployment now contemplated -- a deployment involving ubiquitous mobile and portable use with thousands, if not tens of thousands, of base stations -- is vastly different from that seen to date.

Likewise, WCS has argued that the flight test community should have installed filters, or otherwise "adjust[ed]" to WCS interference.[10] WCS fails to mention that, if AMT had installed filters, it would have filtered out the very telemetry signals flight test engineers were trying to receive! It is also unclear to AFTRCC what adjustments it could have made given the uncertainties concerning WCS and the ultimate rules therefor.

E. Coordination Requirements

If, despite AFTRCC's submissions, the Commission were to continue on the course set forth in the Public Notice, the need for a stringent prior coordination requirement for WCS coupled with an unconditional and immediate obligation for WCS shut-down of any upper-band base stations within line-of-sight of an AMT receiver upon receipt of a complaint of interference to AMT, is imperative. Given WCS' studied difference for the interference their operations will cause to aviation safety, it would be foolhardy to assume WCS would do anything other than continue that pattern when faced with actual interference complaints. On the contrary, a requirement other than immediate shut-down is an invitation to endless argument as WCS

[9] See, e.g., NextWave ex parte of November 23, 2008 re-filed April 5, 2010.
[10] WCS Reply Comments filed March 17, 2008 at 53-54.

operators all the while continue to compromise flight test operations. Even an expedited FCC procedure would be no substitute given the aviation safety issues at stake.

Furthermore, while a shut-down/suspension of upper band operations might entail slower throughput for WCS until the interference is rectified, in most cases the WCS licensee will be able to continue operations using its lower band channels. By contrast, for AMT the mere threat of interference precludes the possibility of conducting flight tests in the spectrum near WCS upper band operations, with significant potential cost impacts on the aerospace industry.

One final point on coordination. WCS coordination will entail burdens for AFTRCC and NTIA. However, those burdens should be no more onerous than absolutely necessary. The Commission has proposed ambitious substantial service performance requirements for WCS licensees, which will add to the coordination burden.[11] AFTRCC is prepared to work with WCS licensees in good faith on such coordination efforts; however, meeting the performance requirements may be challenging for WCS when accounting for the time required to accomplish proper coordination.

Conclusion

AFTRCC's demonstration of the interference risk to aviation from the proposed rules stands unrebutted. Having in effect conceded the risks, WCS is in no position to now argue that a stringent coordination regime is unnecessary in order to prevent that interference. Any other result would disregard the Commission's historic protection for aviation safety, not to speak of its very recent and conspicuous representation in the *Broadband Plan* that adjacent incumbents, in particular AMT, would be "protect[ed]."[12]

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[11] See Public Notice on WCS Performance Requirements, FCC 10-46, March 29, 2010.

[12] *Id.* at Recommendation 5.8.1.

For the foregoing reasons and those stated in its earlier filings, AFTRCC urges the Commission to resolve this proceeding in accordance with these Comments.

Respectfully submitted,

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Engineering Statement

23 April 2009

In its previous filings,[1] AFTRCC has demonstrated that there is a serious risk of interference to Aeronautical Mobile Telemetry (AMT) operations in the band 2360 – 2390 MHz ("AMT Band") from regulations proposed for the Wireless Communications Service ("WCS"). This Statement provides brief additional comments on the recent Public Notice concerning proposed rules for WCS.

The Public Notice proposes that the power level measurement would be changed from peak power to average power with OOBE peak-to-average excursions of as much as 13 dB allowed for up to 0.1% of the time.[2] This constitutes a significant relaxation to the existing rules and will permit harmful interference to AMT operations.

The percentage of time WCS systems will reach or exceed 13 dB depends on the specific technical parameters of the deployed system(s). However, a restriction of only 0.1% is likely much less stringent than is actually practical -- a level that is as restrictive as 0.01% may be achievable. This is based on inspection of the Complementary Cumulative Power Distribution Functions (CCDFs) for OFDM systems similar to those proposed by WCS. This is illustrated, for purposes of discussion, in Figure 1,[3] where the vertical scale indicates the proportion of time that a particular peak-to-average level, given by the horizontal axis, is exceeded. For example, for an OFDM signal having 512 subcarriers, the value of 8 dB on the horizontal axis corresponds to a value of 5×10^{-1}, or 0.5, on the vertical axis. This means that one-half, or 50% of the time, the peak-to-average excursions are less than 8 dB. By implication, for the other 50% of the time, the peak-to-average excursions exceed 8 dB. Note that the particular values to be used in such analyses depend on the specific number of OFDM subcarriers that are used, as characterized by the multiple curves on the graph.

Excursions of ~8 dB can occur in half the typical OFDM data frames (as stated above, corresponding to a value of 5×10^{-1} on the vertical scale in the figure for the case of 512 subcarriers), and each data frame will have a time duration per-frame on the order of 100 microseconds. During each of these frames, a typical AMT system downlinks 500 data bits. Thus, interference at the 8 dB level alone will be continuous and ongoing, and will, when test aircraft are flying at long distances from the telemetry ground station, corrupt fully 50% of an AMT data stream. In practice, the entire data stream will be lost, as AMT receivers will be unable to maintain bit synchronization (a requirement for the successful reception of data). A few seconds later, the AMT antenna control unit (ACU)

[1] See, e.g., AFTRCC ex partes filed November 17, 2008; August 14, 2009; and March 23, 2010.
[2] Public Notice, DA 10-592, April 2, 2010.
[3] Figure 1 is representative of an OFDM signal, but not necessarily the specific WiMAX signal that will be implemented by WCS. Much depends on the specific implementation of broadband wireless in this band, which in turn will depend on the rules that the Commission imposes.

will lose lock and the ground station tracking antenna will no longer be able to point correctly at the test aircraft as it travels at speeds of over 400 knots.

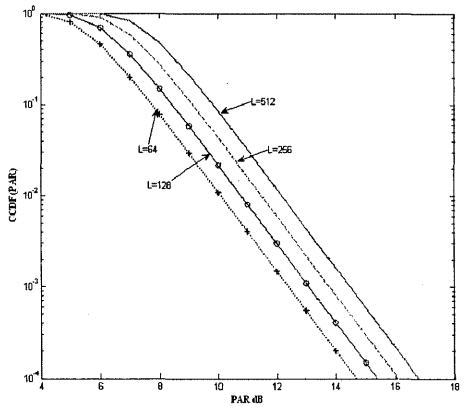

Figure 1. "The Figure shows a plot of the CCDFs of the PAR for OFDM systems with different numbers of subcarriers (L=64, 128, 256, 512), it is clear that the PAR increases as L increases but not nearly linearly." (from Eltholth, et al.)[4]

Interference at the 13 dB level, on the other hand, will occur less often, but will impact AMT telemetry links when the flight test aircraft is closer to its ground station than the distance at which 8 dB excursions cause interference. (This is because the higher interference level causes dropouts to occur even when the received telemetry signal at the ground station is more powerful due to the reduced aircraft/ground-station separation.)

Under these close-in conditions, there will be a loss of 500 contiguous data bits, as described above, during the 0.1% of the WiMAX frames for which the peak to average excursion reaches the 13 dB value -- one of every thousand 100-microsecond frames under the rules proposed (i.e., approximately once every 100 milliseconds), but only one tenth as often under the 0.01% limit proposed above (i.e., once per second). However, 13 dB excursions will cause interference to AMT downlinks when aircraft are approximately half the distance to the AMT ground station at which interference is caused by 8 dB excursions. Thus, although this level of interference will be more sporadic, during every tenth of a second to a second, depending on the final rules, there will be a loss of 500 contiguous AMT telemetry data bits when the aircraft is flying at even nominal distances (50 miles instead of 100 - 200 miles) from the telemetry ground station.

[4] Ashraf A. Eltholth, Adel R. Mikhail, A. Elshirbini, Moawad I. Moawad, A. I. Abdelfattah, "Peak-to-Average Power Ratio Reduction in OFDM Systems using Huffman Coding" World Academy of Science, Engineering and Technology 43 2008, at http://www.waset.org/journals/waset/v43/v43-51.pdf

Furthermore, antenna gains of WCS base stations are expected to be approximately 8 dBi,[5] consistent with the properties of the tower-mounted sectoral antennas used for cellular telephone operations. The Commission proposes to measure out of band emissions at the WCS transmitter, rather than as an EIRP level at the aperture of the WCS antenna. Thus, for WCS base stations there will be, from an AMT perspective, a *de facto* additional increase in permitted OOBE of 8 dB above the levels listed in the proposed rules.

In other words, the OOBE levels proposed by the Commission understate the impact of OOBE on AMT data links by a combined factor of at least 16 dB: 8 dB for gain of the WCS base station antenna, and a minimum of 8 dB for the effect of using average, rather than peak power. In the proposed rules, only 5 dB has been added to the proposed protection levels, with respect to the current Commission rules, to compensate for these combined effects.

Thus, a protection level of 43 + 10 log (P_{avg}), when used to compute interference to an AMT link from a WCS base station, must be regarded, for over 99% of the time, as being 43 – 16 + 5 + 10 log (P_{avg}) -- or only 32 + 10 log (P_{avg}). For the remaining 1% of the time, peak to average excursion will exceed 8 dB, reaching levels of 13 dB either 0.1% or 0.01% of the time, depending on the final rule adopted.

The bottom line is that absent OOBE restrictions that are significantly more stringent than those given in the proposed rules, and without anything more in the way of protection, operation of flight test telemetry links in the band 2360 – 2370 MHz when line of sight exists between a WCS base station and an AMT ground station, will not be possible. At these frequencies, the maximum distance from a telemetry ground station at which a flight test aircraft can successfully downlink data will be compromised: Every 6 dB increase in interference -- even momentarily due to peak-to-average power excursions -- will decrease the maximum range at which a test aircraft can fly by a factor of two.

Absent a rigorous coordination/shut-down requirement, this will have the effect of limiting -- or even precluding altogether -- use of the lower portion of the AMT band, i.e. 2360-2365 or even 2360-2370 MHz, at numerous flight test facilities.

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[5] The gain afforded by an 8 dBi antenna is a common value that optimizes both capacity and coverage for a cellular network.